CHARACTERIZATION OF END-OF-LIFE RESIN-BONDED NdFeB MAGNETS

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Polymer (resin)-bonded NdFeB magnets are typically obtained by mixing NdFeB powder with a binder such as a polymeric binders at an appropriate mixing ratio in a mixer or extruder and subjecting the pellet-shaped extrudate to injection molding or compression molding.[1] Imbedding the magnet powder within a polymer matrix facilitates the formation of complex shaped magnets. Hence, bonded magnets are currently used in various fields, the scope of which is constantly expanding. The demand for polymer-bonded NdFeB magnets has increased because of their superior mechanical characteristics, corrosion resistance, magnetic properties, and facile processing condition.[2] The polymeric binders that shape the NdFeB permanent magnets can be composed of different materials: thermoplastic polyolefin; polyphenylene sulphide (PPS), polyvinyl chloride (PVC), latex or rubber, polypropylene (PP), polyethylene (PE), high density polyethylene (HDPE), polyamide or thermosetting epoxy resin, nitrile rubber or other elastomers. Bonded magnets provide an almost infinite variety of combinations of mechanical, physical, chemical, thermal and magnetic properties due to various kinds of polymeric matrices.[3] For instance, epoxy resins may be reacted (cross-linked) either with themselves through catalytic homopolymerization, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols and thiols (Figure 1).

The market share of resin-bonded magnets demands for efficient recycling processes enabling to separate the polymer matrix from the magnetic powder from end-of-life products. Compared to recycling of sintered NdFeB magnets, very little research efforts have been invested in the recycling of polymer-bonded NdFeB magnets.[4] This research focuses on the characterization of different resin- bonded magnets and their additives using methods such as infrared and Raman spectroscopy, thermal analysis (DSC and TGA), determination of elemental composition (CHN, TXRF, ICP-OES).

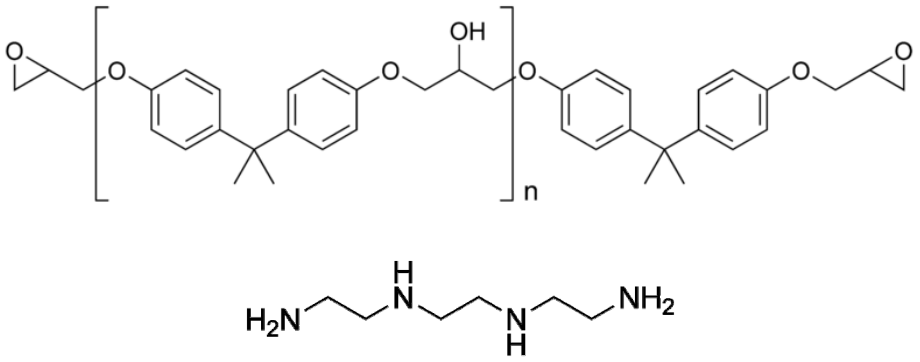

Fig. 1 Example of constituents of an epoxy resin (pre-polymer and hardener) before a curing reaction occurs.

This study will serve as an aid to select the solvents and catalysts that are able to cleave the bonds of the different polymer matrixes. A next step would be optimizing a solvolysis process as a first step in the total recycling of resin bonded magnets. It is understood that powerful solvents and/or increased temperature and pressure is need to break up such the resin. Knowledge on polymer and metal alloy dissolution must be combined to develop a process that selectively dissolves the resin.

References

1. J. Li, Y. Liu, S. J. Gao, M. Li, Y. Q. Wang, M. J. Tu, "Effect of process on the magnetic properties of bonded NdFeB magnet", *J. Magn. Magn. Mater.* **2006,** 299, 195-204.
2. X. Zhang and W. Xiong, "Effect of bonding process on the properties of isotropic epoxy resin-bonded Nd-Fe-B magnets", *Rare Mat.* **2009,** 28, 248-252.
3. Suprapedi and P. Sardjono, "Physical and magnetic properties, microstructure of bonded magnet NdFeB prepared by using synthesis rubber." *J. Phys. Conf. Ser.* **2016,** 776, 012015.
4. K. Binnemans, P. T. Jones, B. Blanpain, T. Van Gerven, Y. Yang, A. Walton and M. Buchert, "Recycling of rare earths: a critical review." *J. Clean. Prod.* **2013,** 51, 1-22.